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ORIGINAL RESEARCH

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An Eggshell Membrane-based Supplement Is Well Tolerated by Senior Cats and Can Improve Their Mobility, According to Owners

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Abstract

Aim: A joint supplement based on eggshell membrane and three other main ingredients known to have beneficial effects on joint health was developed for cats (Movoflex® Soft Chews for cats, Virbac). The aims of the studies presented here were to assess its tolerance and its effectiveness in cats with mobility issues.

Methods: To assess tolerance, 3 groups of cats receiving either nothing (control), one chew per day (recommended label amount), or five chews per day, were assessed over 28 days (n = 8 per group). General health, food consumption, and stool consistency were checked daily, and a complete physical examination was performed weekly. Blood and urine samples were also analyzed. Owners of 71 senior cats with mobility issues then tested the supplement over two months. They assessed different mobility parameters, including general mobility, ability to walk, jump, or stand, filling questionnaires sent regularly from day 0 to day 60. The evolution of the parameters was analyzed with a statistical significance set for $p < 0.05$.

Results: No product-related adverse event was reported in the tolerance study. Evaluation by owners showed that 92% of cats accepted the chew either by hand, on a bowl, or mixed with food. The general mobility score significantly improved from day 7. Other parameters, like gait, ability to stand, jump, or play, were also improved during the study, and 63% of owners considered their cat's mobility improved.

Conclusion: The supplement tested is therefore well tolerated, well accepted by senior cats, and can help improve their mobility as of day 7.

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INTRODUCTION

Mobility issues, such as osteoarthritis (OA), can affect 60% to 90% of cats aged 6 years and over, with the hips, elbows, stifles, shoulders, and tarsal joints being the most affected according to radiographs [1,2]. Osteoarthritis prevalence increases with age, with 90% of cats 10 years and over being affected. Osteoarthritis could even be found in all cats over 16 years [2]. Studies have shown that the neuter status at 6 months of age (entire), obesity, a history of trauma, and outdoor activities, could represent other risk factors, besides age [3]. Some breeds, such as the Maine Coon, are more prone to hip dysplasia that will inevitably lead to OA [4,5].

Despite clear detectable radiographic evidence of OA, and the known pain it can create in animals, the disease is still underdiagnosed in cats, as the signs of pain and clinical evidence of a mobility

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disorder are often remarkably concealed in this species, even when examined by veterinarians [6]. Owners usually seek consultation with veterinarians when cats start to show changes in behaviors, including decreased mobility and grooming, and increased inappropriate elimination [1,2,6]. At this stage, the disease has had time to progress, and the quality of life of cats and their owners, as well as the human-animal bond are significantly impacted.

Osteoarthritis (also known as degenerative joint disease or osteoarthrosis) is a chronic condition characterized by a structural and functional decline of the synovial joint. It is a complex disease, involving local tissue damage, as well as local and systemic inflammatory responses. There is no cure for OA, and the management usually involves a combination of therapies to limit the disease evolution, inflammatory process and pain, and to improve the animal's quality of life [7]. Pharmacological agents like non-steroidal anti-inflammatory drugs (NSAIDs) and analgesic medication are usually prescribed along with health supplements and dietary modifications (to control weight and provide additional omega-3 fatty acids intake). Environmental changes to help the cat move around more easily and physical rehabilitation to soothe pain and improve range of motion, are also part of OA management. Alternatives to medicines could also be considered, such as acupuncture, although more studies are required to confirm their efficacy in such conditions [7].

As far as health supplements are concerned, a recent systematic review supported that supplements based on omega-3, cannabidiol (CBD), or collagen (including eggshell membrane-based nutraceuticals) could have relative efficacy in canine and feline osteoarthritis [8].

The supplement tested here (Movoflex® Soft Chews, Virbac, France) is a health supplement that can help support joint health as demonstrated in dogs [9–11]. The product for cats contains a synergistic blend of four key ingredients of natural origin already present in the dog product [11]. It contains eggshell membrane (ESM), a complex ingredient that contains different molecules naturally found in joints, including collagen, glucosamine, glycosaminoglycans, elastin, hyaluronic acid, and other proteins and amino acids (mainly proline, glutamic acid, and glycine) that can help support protein synthesis [12,13]. The specific eggshell membrane used in Movoflex has a proven record of efficacy in humans [14,15] and dogs [16] with mobility disorders.

This supplement also contains hyaluronic acid (HA) of different molecular weights (MW) to act on lubrication and viscoelasticity of the synovial fluid, resilience of the cartilage, and to help initiate restorative processes in the joint [17,18].

To help address oxidative stress and inflammatory processes that are part of the mechanisms of joint disorders [19], astaxanthin and krill meal were also included in this supplement. Astaxanthin from *Haematococcus pluvialis* (a microalgae, cultivated in bioreactors, that produces and concentrates the compound) is a potent antioxidant [20,21], much more powerful than other carotenoids and vitamin E [22], that can help regulate the immune system in cats [23].

Krill meal (obtained from a sustainable environment-certified fishery) is a source of omega-3 fatty acids coming in the form of readily absorbable phospholipids [24]. Krill is known to improve joint health [25–28] and its content in phospholipids can also help improve the absorption of astaxanthin [29,30] and HA [31].

Although similar formulations of Movoflex® Soft Chews have demonstrated good tolerance and effectiveness in dogs with mobility disorders [9–11], this health supplement has never been tested in cats. Product tolerance was first tested in a cattery, where cats received one or five times the recommended daily amount of one chew per day, for one month. The supplement was then tested in the field in cats with mobility issues to assess effectiveness on mobility, as judged by their owners.

MATERIALS AND METHODS

The test product was Movoflex® Soft Chews for cats (Virbac, France). This feed supplement contains 4 main ingredients: 3.3% of ESM; 1.85% of krill powder; 0.49% of HA; 0.26% of algae meal (*Haematococcus pluvialis*). The recommended daily amount is one chew per day.

Twenty-four healthy adult cats were included in the tolerance study and were allocated to 3 groups (n = 8 per group, 4 males and 4 females in each group). The first group did not receive any product, the second group was given 1 chew per day as recommended, and the third group was given 5 chews per day, corresponding to 5 times the recommended daily amount. Female and male cats were

in separate catteries, under controlled temperature. During mealtime and chew distribution, the cats were housed depending on their group (4 females or 4 males) for a maximum of 4 hours per day. The groups remained unchanged until the end of the study to allow evaluation of product intake, food consumption, and stool examination. Outside this short period, the cats receiving the chew(s) (8 females and 8 males) were housed together after opening trapdoors, while the control cats remained separated.

The chews were distributed daily for 28 days (from D0 to D27) in a bowl or on the ground for a spontaneous intake, before food distribution. The chew was sometimes mixed with kibbles or wet food to promote its intake. All cats received the same food (Veterinary HPM® Adult Cat Neutered, Virbac, France) in adapted quantities during the study period, and water was provided *ad libitum*.

A 14-day acclimation period was implemented to assess daily food consumption and stools appearance (dry/molded or liquid) and to get baseline information. The evaluation of these 2 parameters was maintained during the test period. The animals were observed daily to report any anomaly and a physical examination, including rectal temperature and body weight measurements, was performed weekly throughout the study. Blood and urine were sampled during the acclimation period, and at the end of the study, for hematology and blood biochemistry analysis, and for urine analysis (pH and urine specific gravity—USG).

For blood collection, the jugular area was clipped before blood sampling. At each time point, 2 mL of blood was collected in EDTA tubes for hematology and 4 mL in plain tubes for blood biochemistry analysis. The tubes were first shaken for homogenization and the EDTA tubes were analyzed quickly after sampling. Plain tubes were left to decant for a minimum of 30 minutes, then centrifuged at 2000 *g* for 10 minutes at room temperature for serum collection. Serum analysis was carried out on the day of sampling.

Urine was collected in fasted and anesthetized animals by ultrasound-guided cystocentesis. The target volume was at least 4 ml but depended on urine bladder repletion. At least two drops were used after urine sampling for USG measurement, using a refractometer 1080 SpG. The remaining urine was collected on a plain tube for pH measurement immediately after urine collection, using a pH meter.

At the end of the in-vivo phase, the animals returned to the Animal Unit Colony.

This study was conducted according to Virbac procedures and approved by the Virbac Ethical Committee and the French Authorities.

The efficacy study was conducted in France, by Techni'Sens (La Rochelle, France) and involved seventy-one family-owned cats. Each cat was older than 10 years of age, had mobility issues for more than 3 months but was not obese according to the owner. Mobility issues were defined as either the cat had a confirmed diagnosis of OA by a veterinarian or it presented any of the following signs: difficulty to walk, difficulty to climb, difficulty to jump up or down furniture (chair, bed, sofa, etc.), difficulty to stand or change position, abnormal gait, reacting when touched or hold, and being less active than before. The test product was provided by the monitor of the study to pet owners with no identification or link to the product brand name. For 60 days, the owners gave their cat one chew a day. Questionnaires to fill in were sent to them at D0, D7, D14, D30, and D60. For mobility assessment, seven parameters were scored from 0 to 10 (the higher the better): General mobility; Gait; Ability to walk; Ability to stand after lying down; Ability to jump up on furniture (sofa, bed…); Ability to play; Interaction with people (only on days 0, 30, and 60). The global score was obtained by adding up the five scores obtained for gait, ability to walk, stand after lying down, jump up, and play.

Other single-choice questions were asked to describe how the cat was moving or behaving. They included descriptions of how active was the cat, how it was moving (walking, running, or jumping), how the cat was impacted by its mobility issues, how difficult it was for the cat to lie down or to groom itself; how the cat was walking (limping, speed); how the cat was jumping (up or down); how were its interactions with other animals, how was its willingness to play, and what was the impact of playing on mobility issues.

The course of the test was explained by phone to pet owners. They were provided with a paper describing the conditions of use of the product, the dates for sending questionnaires, recommendations and advice on how to give the chew, and a daily logbook so that they could record their observations.

In the safety study, the data between the beginning (initial) and end of the study (final) were com-

pared using paired Student's *t*-tests or Wilcoxon's signed-rank tests, depending on data distribution as verified with a Shapiro–Wilk test.

In the efficacy study, due to the ordinal nature and non-normal distribution of the data for most parameters (except for the global score), non-parametric tests were used. Friedman tests were used to assess the significance of a parameter's evolution over time. Wilcoxon Signed-Rank tests were then used to determine where the significance lay, applying a Bonferroni correction for 4 measurements (4 days of assessment vs. day 0) to assess for significance. For the global score, an ANOVA for repeated measures followed by Tukey tests was used. Nominal data were compared between the groups using Fisher's exact test or chi-square tests, applying a Bonferroni correction for 2 measurements (2 days of assessment vs. day 0) when necessary. The significance threshold was set for a two-sided $p < 0.05$.

RESULTS

During the tolerance study, all cats ate their chews spontaneously during the administration period, except for three females (out of 4) in group 3 (5 chews per day) who only partially ate their chews during the first week, but ate the whole 5 chews spontaneously as of day 6 until the end of the study. The food ration was increased twice during the study to adapt to the animals' body weights. It went from 65g per animal initially to 80g at the end of the study in groups 1 (control) and 2 (1 chew per day) and to 70g in group 3 since the cats also received 5 chews per day. The food was totally consumed most of the time with some leftovers occasionally observed some days in females, in all groups, and with no relation to product consumption.

One vomiting episode was observed in one cat shortly after the spontaneous intake of 5 chews on the first day, but never after. This event was therefore deemed unrelated to product consumption. Body temperatures remained in the physiological range for all cats. No gastrointestinal disorders related to chew consumption were observed during product distribution. Moreover, product intake had no significant effect on body weight (Table 1).

All mean values of the hematology parameters assessed remained in the physiological range. Some slight but significant changes were observed for a few parameters (MCV in the group receiving 1 chew per day, MCH in the group receiving 5 chews per day, and Basophil count in the control group, Table 1) but

Table 1. Data obtained during the tolerance study when cats received either no chew (control), one chew per day as recommended, or five chews per day. Data are presented as means ± SD. *: $p < 0.05$ vs. initial value. MCV: mean corpuscular volume; MCH: mean corpuscular hemoglobin; MCHC: mean corpuscular hemoglobin concentration; BUN: blood urea nitrogen; AST: aspartate aminotransferase; ALT: alanine aminotransferase. $N = 8$ in all groups, except for urine pH ($n = 7, 6, 8$) and urine specific gravity ($n = 8, 7, 8$ in the respective groups), since not enough urine could be collected in all cats.

	Control (No soft chew)		Supplement— 1 soft chews/Day		Supplement— 5 soft chews/Day		Reference Range
	Initial	Final	Initial	Final	Initial	Final	
Body Weight (kg)	3.92 ± 1.1	3.91 ± 1.1	4.15 ± 1.01	4.19 ± 0.9	3.90 ± 0.9	3.89 ± 0.9	
Body temperature (°C)	38.4 ± 0.3	38.4 ± 0.2	38.5 ± 0.2	38.4 ± 0.2	38.4 ± 0.4	38.6 ± 0.3	
Complete Blood Counts							
Hemoglobin (g/dL)	12.3 ± 1.7	11.9 ± 1.3	11.1 ± 1.3	11.1 ± 1.3	10.9 ± 0.8	10.9 ± 1.3	9.8–16.2
Hematocrit (%)	36.1 ± 4.2	36.3± 5.0	33.4 ± 4.7	33.2 ± 4.7	32.3 ± 3.6	32.2 ± 4.4	30.3–52.3
Red blood cells (M/µL)	9.07 ± 0.58	9.10 ± 0.65	8.36 ± 1.01	8.53 ± 1.11	8.35 ± 0.48	8.55 ± 0.67	6.54–12.20
MCV (fL)	39.8 ± 3.6	39.7 ± 3.4	40.0 ± 3.7	39.1 ± 3.4* ($p = 0.027$)	38.8 ± 3.8	37.7 ± 3.9	35.9–53.1
MCH (pg)	13.5 ± 1.7	13.0 ± 0.9	13.3 ± 0.8	13.1 ± 0.9	13.1 ± 0.9	12.7 ± 1.0* ($p = 0.014$)	11.8–17.3
MCHC (g/dL)	34.0 ± 2.5	32.8 ± 1.6	33.3 ± 1.7	33.6 ± 1.8	33.9 ± 1.4	33.9 ± 1.1	28.1–35.8
Reticulocytes (K/µL)	11.9 ± 6.4	11.9 ± 6.0	11.6 ± 4.2	10.7 ± 4.6	8.3 ± 3.8	10.1 ± 3.7	3–50
Platelets (K/µL)	388 ± 99	386 ± 83	329 ± 94	339 ± 112	354 ± 81	353 ± 108	151–600

(Continued)

	Control (No soft chew)		Supplement— 1 soft chews/Day		Supplement— 5 soft chews/Day		Reference Range
	Initial	Final	Initial	Final	Initial	Final	
White blood cells (K/µL)	7.48 ± 2.08	7.55 ± 2.27	7.89 ± 1.15	7.98 ± 1.89	8.00 ± 2.32	9.51 ± 3.91	2.87–17.2
Neutrophils (K/µL)	3.46 ± 1.12	3.57 ± 1.37	3.34 ± 0.87	3.69 ± 1.65	3.93 ± 1.60	5.36 ± 3.92	1.48–10.29
Lymphocytes (K/µL)	2.97 ± 0.88	2.93 ± 1.05	3.55 ± 0.73	3.32 ± 0.84	3.15 ± 1.18	3.10 ± 1.19	0.92–6.88
Monocytes (K/µL)	0.24 ± 0.08	0.23 ± 0.08	0.24 ± 0.05	0.27 ± 0.06	0.28 ± 0.11	0.32 ± 0.15	0.05–0.67
Eosinophils (K/µL)	0.71 ± 0.24	0.75 ± 0.31	0.70 ± 0.22	0.64 ± 0.19	0.59 ± 0.25	0.67 ± 0.29	0.17–1.57
Basophils (K/µL)	0.10 ± 0.06	0.08± 0.06* (p = 0.033)	0.06 ± 0.02	0.07 ± 0.01	0.05 ± 0.03	0.06 ± 0.03	0.01–0.26
Blood Chemistry							
Glucose (g/L)	0.86± 0.18	0.78 ± 0.10	0.78 ± 0.13	0.72 ± 0.08	0.82 ± 0.12	0.73 ± 0.06* (p = 0.046)	0.74–1.59
Sodium (mmol/L)	161 ± 2	162 ± 1* (p = 0.022)	162 ± 2	162 ± 1	163 ± 2	163 ± 2	150–165
Potassium (mmol/L)	4.3 ± 0.5	4.3 ± 0.4	4.4 ± 0.4	4.4 ± 0.3	4.1 ± 0.4	4.1 ± 0.5	3.5–5.8
Chloride (mmol/L)	119 ± 2	120 ± 2	120 ± 1	120 ± 1	120 ± 2	120 ± 1	112–129
Calcium (mg/L)	96 ± 3	94 ± 3* (p = 0.029)	98 ± 4	98 ± 3	98 ± 4	96 ± 4	78–113
Magnesium (mg/L)	22 ± 1	22 ± 2	21 ± 1	21 ± 2	21 ± 1	21 ± 1	15–30
Phosphate (mg/L)	50.1 ± 7.62	51.0 ± 6.74	47.0 ± 6.88	47.4 ± 7.26	46.2 ± 5.06	45.3 ± 5.88	31–75
BUN (g/L)	0.47 ± 0.06	0.48 ± 0.07	0.47 ± 0.04	0.46 ± 0.04	0.46 ± 0.08	0.45 ± 0.07	0.34–0.76
Creatinine (mg/L)	15.0 ± 4.4	11.6 ± 2.9* (p = 0.002)	15.9 ± 4.5	12.5 ± 3.7* (p < 0.001)	16.2 ± 3.7	12.4 ± 2.7* (p = 0.002)	8–24
Total Protein (g/L)	64 ± 2	67 ± 3* (p = 0.014)	69 ± 5	71 ± 7	70 ± 3	71 ± 4	57–89
Albumin (g/L)	32 ± 2	33 ± 2	34 ± 2	34 ± 2	34 ± 2	34 ± 2	22–40
Globulin (g/L)	32 ± 2	34 ± 2* (p = 0.003)	35 ± 4	36 ± 5	35 ± 3	37 ± 4	28–51
AST (IU/L)	30 ± 16	28 ± 13	22 ± 6	30 ± 9	24 ± 9	23 ± 5	0–48
ALT (IU/L)	72 ± 18	66 ± 16	60 ± 20	66 ± 22	68 ± 31	65 ± 18	12–130
Alkaline Phosphatase (IU/L)	29 ± 12	29 ± 6	29 ± 6	29 ± 8	25 ± 9	27 ± 7	14–111
Urine Chemistry							
pH	6.25 ± 0.27	6.09 ± 0.34	5.82 ± 0.15	5.86 ± 0.02	5.95 ± 0.08	5.91 ± 0.18	5.3–7
Specific Gravity	1.062 ± 0.01	1.060 ± 0.01	1.061 ± 0.01	1.058 ± 0.01	1.057 ± 0.00	1.053 ± 0.01	1020–1065

Add p values to table

with no clinical implication and no relation to treatment. Some blood biochemistry parameters were also slightly modified, like blood glucose, which decreased in all groups, so that the final value was below the reference range in the groups receiving the chews. However, cats in these groups started the study with a lower blood glucose level than those in the control group, and the variation between initial and final did not differ between groups (mean of -0.08, -0.07, and -0.08 g/L in the respective groups). The change is therefore unrelated to treatment. Creatinine levels also significantly decreased in all groups but remained in the physiological range. Other parameters (total proteins, globulin, sodium, and calcium) slightly changed in the control group but remained in the physiological range and had no clinical significance (Table 1). There was no change in urine pH and specific gravity; all mean values remained in the physiological range with no significant change during the study period (Table 1).

The 71 cats participating in the efficacy study were mainly European or cross-breed cats (40%).

Pure breeds included Maine Coon (20%), Persian (13%), Oriental (7%), Ragdoll (7%), Birman (7%), and Siamese (7%). They were mainly females (51%) and neutered (96%). The mean (SD) age was 13.5 (2.1) years old, and the mean (SD) body weight was 4.6 (1.6) kg. Twelve cats (17%) had veterinarian-diagnosed mobility conditions like OA and five (7%) also had confirmed chronic kidney disease. Concerning mobility issues, 54% of pet owners said the behavior of their cat had changed and that it was moving less; 27% noticed it had difficulty walking and was slower; 25% that it could not jump up or down furniture (bed, chair, sofa, etc.) as easily as before; 17% that it had difficulty to stand or change position; 15% that it reacted when touched at specific areas; 15% that it had difficulty to walk up or down stairs; and 10% that the gait was not normal.

Of the 71 cats (and owners) participating in the study, one was lost to follow-up from day 30, three cats stopped after day 14 as they did not accept the chew, and 3 other cats did not take the chew regularly (more than 50% of the time) and were therefore removed from the efficacy analysis (mobility criteria). On day 14, when all participants were still in the study, 65/71 cats (92%) accepted to take the chew either by hand, on a bowl, or mixed with food.

Very few self-limiting mild gastrointestinal disorders were described during the study: 2 cats with softer stools were reported on day 7; 3 cats with harder stools on day 60, and 6 cases of vomiting were reported during the study (2 on day 7, 2 on day 14, and 2 on day 60). None of these disorders required medical assistance. No other disorders were reported.

To assess mobility, the cat owners were asked to score seven mobility parameters from 0 to 10 (the higher the score, the better) to assess how these parameters evolved over time with the test product. All parameters but one (ability to walk) significantly improved over time ($p < 0.001$ for general mobility—$n = 64$—and ability to play—$n = 43$; $p < 0.01$ for gait—$n = 64$, ability to stand after lying down—$n = 64$, and ability to jump on furniture—$n = 59$; and $p < 0.05$ for interaction with people—$n = 64$).

The general mobility score significantly improved as of Day 7 (Figure 1A). The ability to stand after lying down and the ability to jump up on furniture were significantly improved as of day 14 (Figure 1D and E, respectively). The gait significantly improved on days 14 and 60 (Figure 1B), and the ability to play on day 60 (Figure 1F). When adding up the scores for the 5 parameters (gait, ability to walk, stand, jump, and play), the global score significantly improved over time ($p = 0.002$) and as early as day 14 (Figure 1G). The last parameter assessed on a 0–10 scale was the ability to interact with people (measured only on days 0, 30, and 60). While this parameter was significantly improved over time ($p = 0.045$), the assessment by time point versus day 0 revealed no significant difference (Figure 1H).

Over time, significantly more owners described their cats as being moderately to extremely active (from 23/64—36%—on day 0 to 41/64—64%—by day 30; $p = 0.001$; Figure 2A); walking, running, and jumping normally (from 10/64—16%—to 26/64—41%—by day 30; $p = 0.002$, Figure 2B); or jumping normally on furniture (from 13/59—22%—to 26/59—44%—on day 30; $p = 0.01$; Figure 2C).

Significantly more owners also described their cats as being able to lie down normally (from 35/64—55%—to 51/64—80%—by day 60; $p = 0.003$, Figure 3A); having no or a slight stiffness after lying down (from 35/64—55%—to 50/64—78%—by day 30; $p = 0.005$, Figure 3A); and playing often or a bit with other animals (from 10/47—21%—to 24/47—51%—by day 30; $p = 0.003$, Figure 3C).

Despite tendencies for improvement, there were no significant differences over time in the replies of pet owners concerning how the cat is impacted by its mobility issues (67% replied the cat was a little or not impacted at all by the end of the study vs. 51% at the beginning); the cat's ability to groom itself (53% replied it seemed easy by the end of the study vs. 44% at the beginning); its way of walking (Figure 4A); its ability to jump down (34% replied it could jump normally vs. 27% at the beginning); to stretch (Figure-4B); or to stand after lying down (42% replied it could stand normally vs 39% at the beginning); its willingness to play (Figure 4C); or the impact of games on its mobility (52% replied it had few or no impact on mobility at the end of the study vs 47% at the beginning).

At the end of the study, on day 60, the owners were also asked to score the level of acceptance of the chew by the cat and to rate their own satisfaction with the test product on a 0–10 scale (10 being highly accepted/satisfied). They were also asked to score, in a similar way, their cat's mobility improvement. They gave a median (Q1–Q3) score of 8 (5–9) for the cat's acceptance of the chew ($n = 67$) with

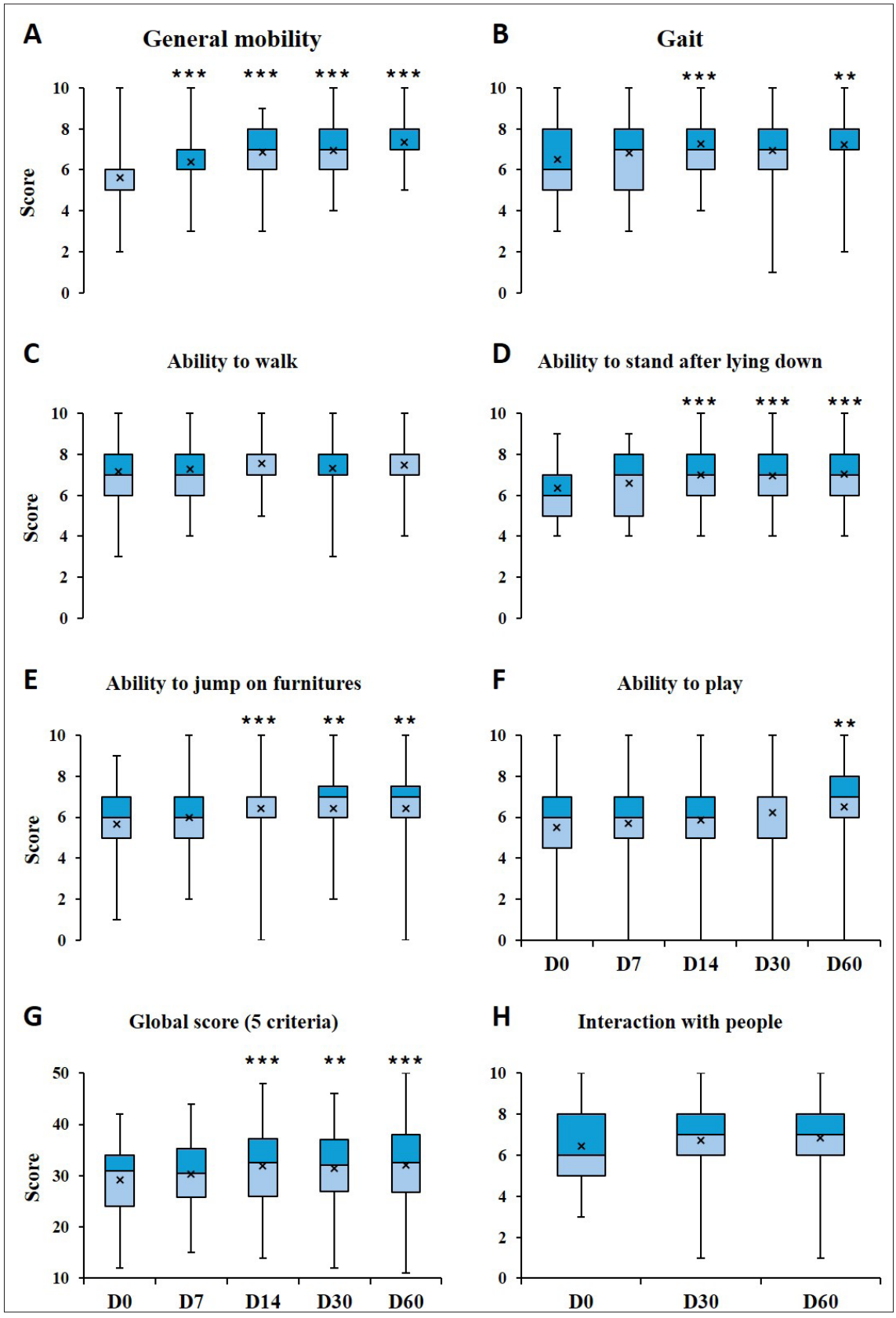

Figure 1. Box plots showing the evolution of scores for several parameters. A–F and H: the parameter assessed by the owner is specified on top of the graph; G: the global score is the sum of the five parameters assessed in B–F. The cross in each graph represents the mean value. **, $p < 0.01$; ***, $p < 0.001$ compared to day 0 (D0).

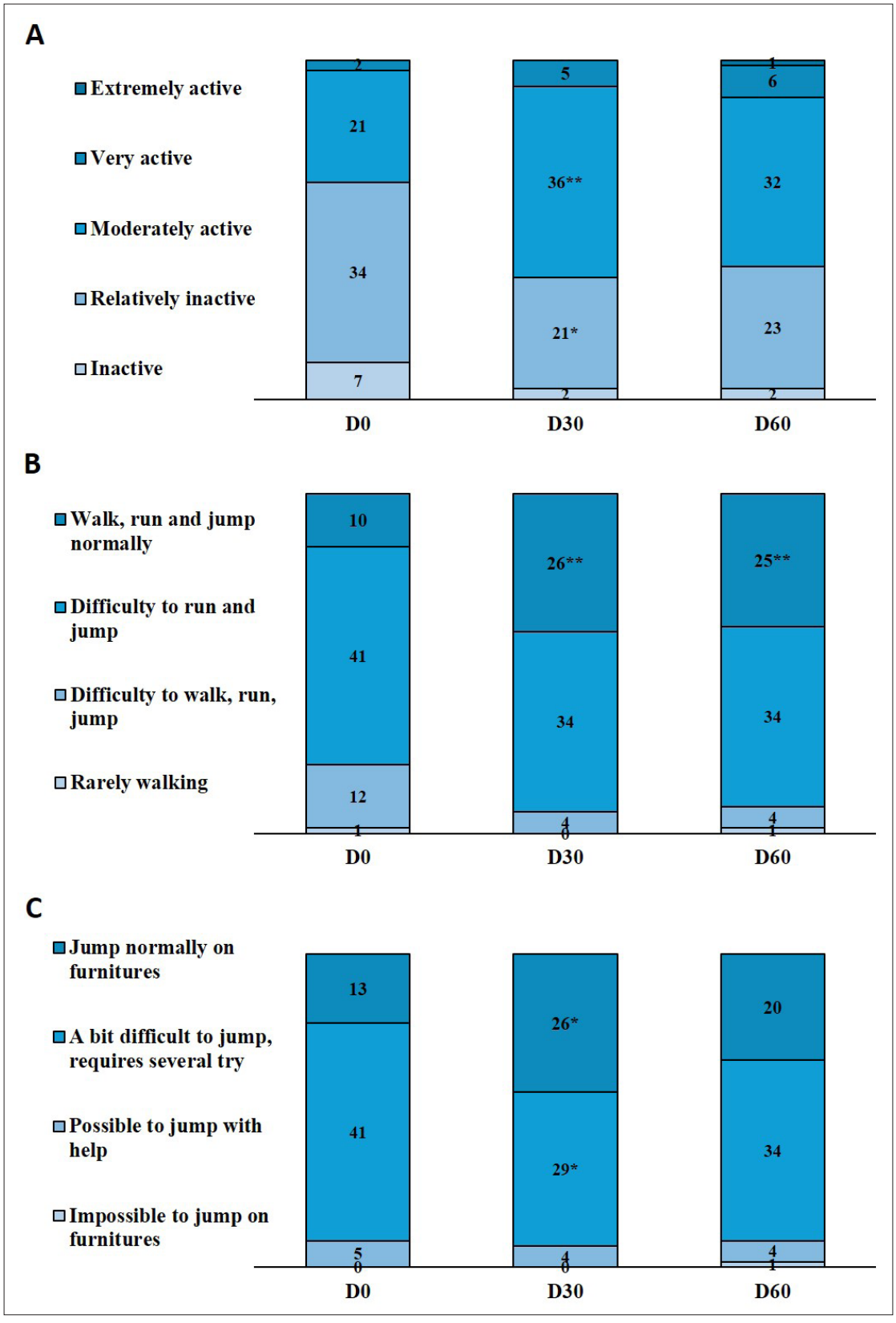

Figure 2. Stacked bar graph showing the number of respondents selecting a specific answer (as described on the left) concerning the cat level of activity (A), how the cat is moving (B), and its ability to jump (C). *, $p < 0.025$; **, $p < 0.01$ compared to day 0 (D0).

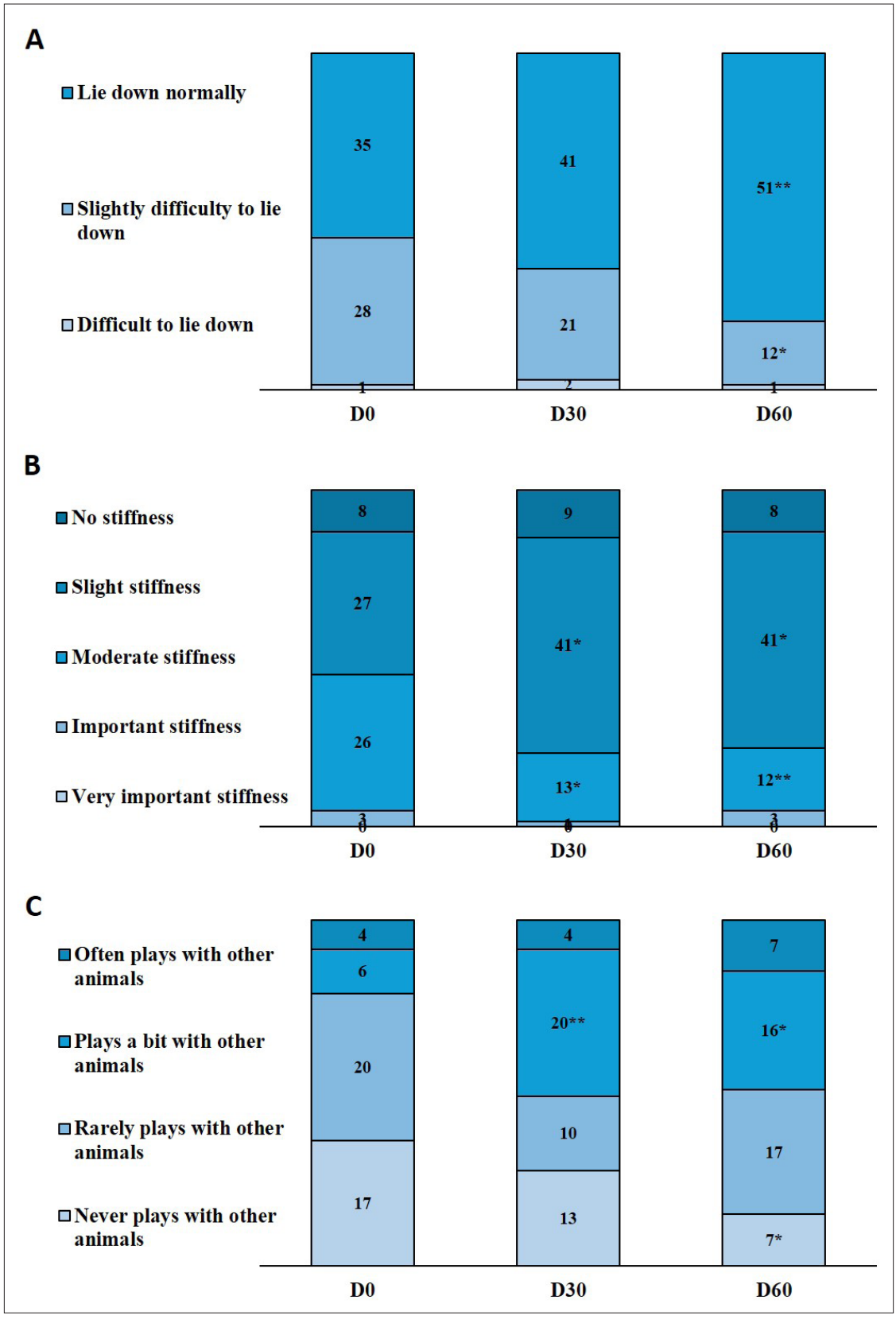

Figure 3. Stacked bar graph showing the number of respondents selecting a specific answer (as described on the left) concerning the cat's ability to lie down (A), its stiffness (B), and how often it plays with other animals (C). *, $p < 0.025$; **, $p < 0.01$ compared to day 0 (D0).

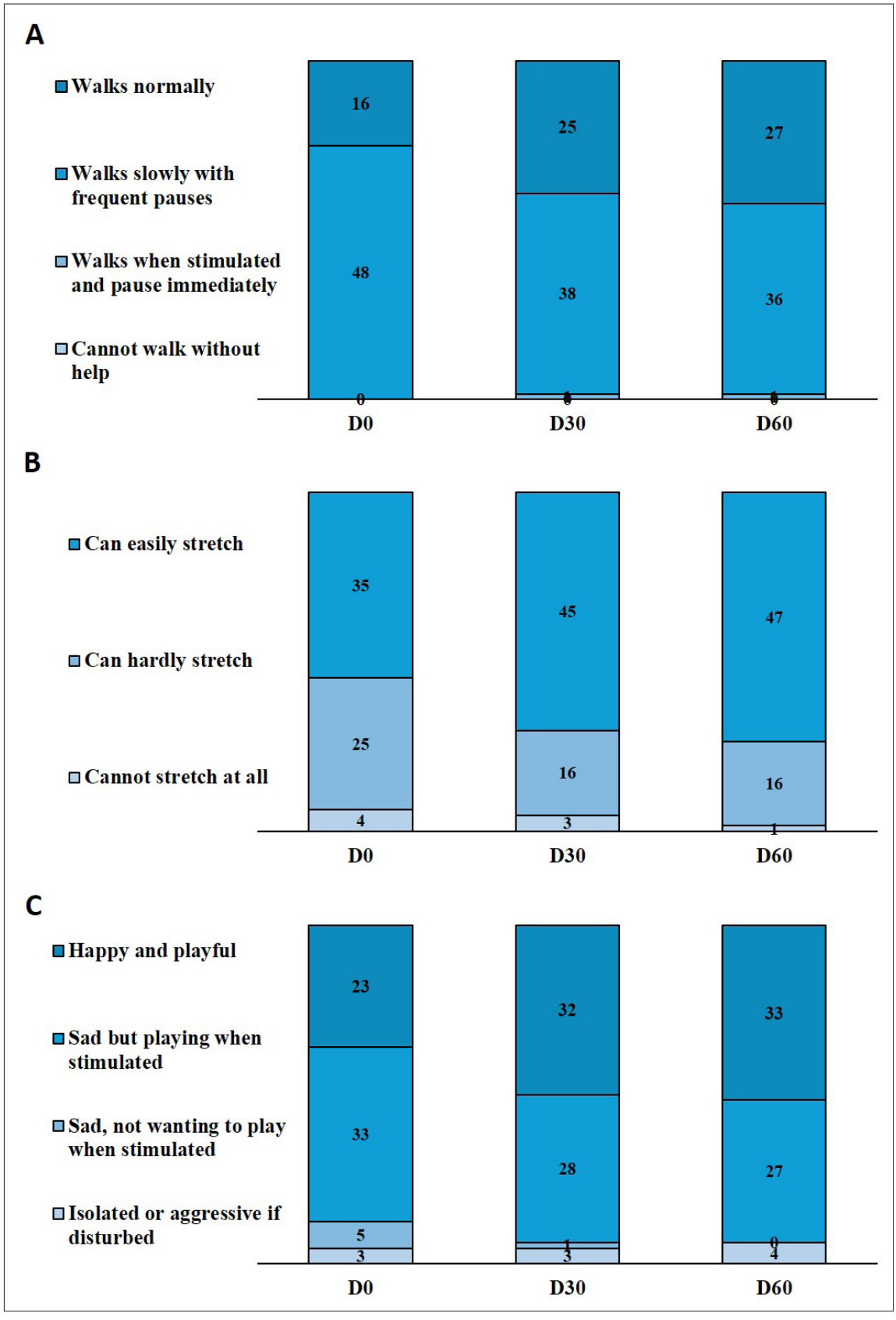

Figure 4. Stacked bar graph showing the number of respondents selecting a specific answer (as described on the left) concerning the cat's way of walking (A), its ability to stretch (B), and its willingness to play (C).

57% of owners seeing a positive evolution of the cat's acceptance from the beginning of the study. They gave a score of 8 (5.75–9) for their overall satisfaction with the test product (n = 67) and a score of 7 (5–8) for mobility improvement (n = 64). By day 30, 63% of respondents considered their cat's mobility improved (n = 64). When asked about purchase intention, 77% said they would buy it if recommended by a veterinarian (n = 64).

DISCUSSION

Overall, the results showed that the joint supplement tested (Movoflex® Soft Chews) was safe for cats, even at five times the recommended daily amount, and efficient in improving mobility, as assessed by the owners.

Like in dogs [11], the general mobility significantly improved as of day 7 and continued to improve until the end of the 60-day study. Other parameters, like gait (way of walking), the ability to stand after a period of rest, to jump up on furniture, or to play or interact with people, were also improved during the study. These are signs easy to observe and monitor by owners of cats with mobility issues, due to OA for example, and that can be improved by standard therapies [6]. They are regularly used in clinical metrology instruments (CMIs), which are questionnaires dedicated to the caregiver and designed to measure the sensory and affective effects of pain [32–34].

Interestingly, while the gait and stiffness improved (Figures 1 and 3), the owner's perception of the cat's ability to walk did not significantly change, suggesting that the stiffness or limping does not impact the cat's ability to move or that it is not perceived as a problem for the cat's walking ability by the owners. It is indeed common for cats to hide or cope with their pain so that they still appear to move as normally as possible. This is one of the reasons why pain assessment is so complicated in cats, and the prevalence of the problem so largely underestimated [6]. Signs can be missed if the caregiver does not pay enough attention.

By the end of the study, more owners described their cats as being more active and moving normally (walking, running, jumping) than at the beginning of the study (Figure 2). Their ability to play also improved, as were the interactions with people (Figure 1) and other pets (Figure 3). Despite these effects and a tendency for improvement, the description of mood and willingness to play was not significantly improved (Figure 4). The mood is probably more difficult to interpret by owners. It is, however, a measure that can help assess the effectiveness of treatments [6,34,35].

The main limitations of this study lie in its design: data come from the owner's perception of the cat's mobility and there was no veterinarian involved, either in the recruitment or in the assessments during the study. The absence of medical validation of the joint disorder, like OA, by a veterinarian can indeed have biased the study, especially if other concomitant disorders or ruptured ligaments were present. In the latter case, no improvement (or few) could be expected with a joint supplement, and it is possible that the effectiveness of the test product was therefore underestimated in this study. However, participants in the study were selected based on the presence of mobility issues in their cats, like difficulties to walk, jump, stand, or climb stairs, and all cats were over 10 years of age (mean age: 13.5 years old). With an OA prevalence reaching 90% in cats older than 10 years [1,2], the likelihood that the cats involved in this study had joint disorders was very high. Among the participants, 17% had confirmed joint disorders like OA. Interestingly, 20% of cats selected were Maine Coons, a breed known for its predisposition to joint disorders [4,5]. Veterinarians cannot always perform a proper joint examination in cats, especially if the animals are very stressed, as regularly observed in the clinic setting [33]. It is approved now that the caregiver's assessment and questions asked to the pet owner are as important, if not more, as the veterinarian's examination [6,33,34]. This is why several questionnaires (such as CMIs) have now been developed [33]. Owners can see their cat evolving in a familiar environment day after day and are the best persons to notice any change in behavior or mobility.

Supplements for joints are part of the multimodal management of joint disorders like OA, as they bring elements to help maintain the cartilage structure [36]. However, not all joint supplements are similar. A recent meta-analysis showed that those containing omega-3 fatty acids, collagen (including ESM), and/or CBD were more efficacious than others [8, 37]. While the test product contains some of these components, the results obtained in the meta-analysis does not prevent from performing studies to specifically validate the efficacy of a given supplement. In this study, the test supple-

ment, containing ESM and omega-3 fatty acids on top of other ingredients, was efficient in improving mobility in senior cats. This product can be part of a multimodal approach that also includes medications such as NSAIDs and opioids-especially during the acute phase physical rehabilitation, weight loss, and a complete and balanced therapeutic diet [34,36,37]. Environmental modifications in the home should also be considered to ease the cat's movements and decrease pain [34]. Such recommendations were not given to owners in this study, but we can suspect that they would have further improved the cats' quality of life.

In conclusion, the supplement tested here (Movoflex® Soft Chews for cats), containing a blend of 4 main ingredients known to have beneficial actions on joint health (ESM, krill as a source of omega-3 fatty acids, hyaluronic acid, and a source of astaxanthin), is a safe supplement to use in cats and can improve mobility from day 7, as perceived by cat owners. It can be part of the multimodal approach to managing cats with joint disorders. A proper controlled clinical study involving veterinarians is further required to confirm the efficacy of the supplement in cats, but this preliminary study already provides very promising results at the pet owner level.

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CONFLICT OF INTEREST

All authors are Virbac employees.

References

1. Slingerland LI, Hazewinkel HAW, Meij BP, Picavet P, Voorhout G. Cross-sectional study of the prevalence and clinical features of osteoarthritis in 100 cats. Vet J. 2011;187(3):304–9.
2. Godfrey D, Vaughan L. Historical Prevalence of Radiological Appendicular Osteoarthritis in Cats (1972-1973). J Am Anim Hosp Assoc. 2018;54(4): 209–12.
3. Maniaki E, Murrell J, Langley-Hobbs SJ, Blackwell EJ. Associations between early neutering, obesity, outdoor access, trauma and feline degenerative joint disease. J Feline Med Surg. 2021;23(10):965–75.
4. Low M, Eksell P, Högström K, Olsson U, Audell L, Ohlsson Å. Demography, heritability and genetic correlation of feline hip dysplasia and response to selection in a health screening programme. Sci Rep. 2019;9(1):17164.
5. Schnabl-Feichter E, Tichy A, Gumpenberger M, Bockstahler B. Comparison of ground reaction force measurements in a population of Domestic Shorthair and Maine Coon cats. PLoS One. 2018;13(12):e0208085.
6. Klinck MP, Frank D, Guillot M, Troncy E. Owner-perceived signs and veterinary diagnosis in 50 cases of feline osteoarthritis. Can Vet J. 2012;53(11): 1181–6.
7. Bennett D, Zainal Ariffin SM bt, Johnston P. Osteoarthritis in the cat: 2. how should it be managed and treated? J Feline Med Surg. 2012;14(1):76–84.
8. Barbeau-Grégoire M, Otis C, Cournoyer A, Moreau M, Lussier B, Troncy E. A 2022 Systematic Review and Meta-Analysis of Enriched Therapeutic Diets and Nutraceuticals in Canine and Feline Osteoarthritis. Int J Mol Sci. 2022;23(18):10384.
9. Muller C, Enomoto M, Buono A, Steiner JM, Lascelles BDX. Placebo-controlled pilot study of the effects of an eggshell membrane-based supplement on mobility and serum biomarkers in dogs with osteoarthritis. Vet J. 2019;253:105379
10. Nicolas CS, Schreiber P, Rème CA, Lopez J, Ereau C. Adding Krill Oil and Low Molecular Weight Hyaluronic Acid to Movoflex® Soft Chews Helps Improve Dog's Mobility. Global Journal of Medical Research. 2022; 12(1):20-32.
11. Nicolas CS, Jouty N, Rème CA, Ereau C. Movoflex soft chews can improve dogs' mobility, according to owners. EC Veterinary Science. 2022;7(10):13-21.
12. Baláž M, Boldyreva EV, Rybin D, Pavlović S, Rodríguez-Padrón D, Mudrinić T, et al. State-of-the-Art of Eggshell Waste in Materials Science: Recent Advances in Catalysis, Pharmaceutical Applications, and Mechanochemistry. Front Bioeng Biotechnol. 2020;8:612567.
13. Rath NC, Liyanage R, Makkar SK, Lay JO Jr. Protein profiles of hatchery egg shell membrane. Proteome Sci. 2016;15:4.
14. Blasco, Aguirre, Gil-Quintana, Fenaux. The effect of daily administration of 300 mg of Ovomet® for treatment of arthritis in elderly patients. Int J Clin Rheumtol. 2016; 11(5):077-81.
15. Gil-Quintana, Fenaux, Nuez, Molero. Short-term effects of ovomet®, eggshell membrane. Joint pain: A double-blind and placebo study. J Osteopor Phys Act. 2018; 6 :1-5.
16. Aguirre A, Gil-Quintana E, Fenaux M. The efficacy of Ovopet in the treatment of hip dysplasia in dogs. and Animal Health. 2018; 10(8):198-207.
17. Gupta RC, Lall R, Srivastava A, Sinha A. Hyaluronic Acid: Molecular Mechanisms and Therapeutic Trajectory. Front Vet Sci. 2019;6:192

18. Iturriaga V, Vásquez B, Bornhardt T, Del Sol M. Effects of low and high molecular weight hyaluronic acid on the osteoarthritic temporomandibular joint in rabbit. Clin Oral Investig. 2021;25(7):4507–18.
19. Zahan O-M, Serban O, Gherman C, Fodor D. The evaluation of oxidative stress in osteoarthritis. Med Pharm Rep. 2020;93:12–22.
20. Oslan SNH, Tan JS, Oslan SN, Matanjun P, Mokhtar RAM, Shapawi R, et al. Haematococcus pluvialis as a Potential Source of Astaxanthin with Diverse Applications in Industrial Sectors: Current Research and Future Directions. Molecules. 2021;26(21):6470.
21. Snell TW, Carberry J. Astaxanthin Bioactivity Is Determined by Stereoisomer Composition and Extraction Method. Nutrients. 2022;14(7):1522.
22. Miki W. Biological functions and activities of animal carotenoids. J Macromol Sci Part A Pure Appl Chem. 1991;63:141–6.
23. Park JS, Mathison BD, Hayek MG, Massimino S, Reinhart GA, Chew BP. Astaxanthin stimulates cell-mediated and humoral immune responses in cats. Vet Immunol Immunopathol. 2011;144(3-4):455–61.
24. Burri L, Johnsen L. Krill products: an overview of animal studies. Nutrients. 2015;7(5):3300–21.
25. Lee M, Kim D, Park S-J, Yun JM, Oh DH, Lee J. Antarctic Krill Oil Ameliorates Monosodium Iodoacetate-Induced Irregularities in Articular Cartilage and Inflammatory Response in the Rat Models of Osteoarthritis. Nutrients. 2020; 12(11):3550.
26. Wang K, Li Y, Dai Y, Han L, Zhu Y, Xue C, et al. Peptides from Antarctic Krill (Euphausia superba) Improve Osteoarthritis via Inhibiting HIF-2α-Mediated Death Receptor Apoptosis and Metabolism Regulation in Osteoarthritic Mice. J Agric Food Chem. 2019;67(11):3125–33.
27. Suzuki Y, Fukushima M, Sakuraba K, Sawaki K, Sekigawa K. Krill Oil Improves Mild Knee Joint Pain: A Randomized Control Trial. PLoS One. 2016;11(10):e0162769.
28. Stonehouse W, Benassi-Evans B, Bednarz J, Vincent AD, Hall S, Hill CL. Krill oil improved osteoarthritic knee pain in adults with mild to moderate knee osteoarthritis: a 6-month multicenter, randomized, double-blind, placebo-controlled trial. Am J Clin Nutr. 2022; 116(3):672-85.
29. Mercke Odeberg J, Lignell A, Pettersson A, Höglund P. Oral bioavailability of the antioxidant astaxanthin in humans is enhanced by incorporation of lipid based formulations. Eur J Pharm Sci. 2003;19(4): 299–304.
30. Chitchumroonchokchai C, Failla ML. Bioaccessibility and intestinal cell uptake of astaxanthin from salmon and commercial supplements. Food Res Int. 2017; 99(Pt 2):936-43.
31. Huang S-L, Ling P-X, Zhang T-M. Oral absorption of hyaluronic acid and phospholipids complexes in rats. World J Gastroenterol. 2007;13(6):945–9.
32. Benito J, Depuy V, Hardie E, Zamprogno H, Thomson A, Simpson W, et al. Reliability and discriminatory testing of a client-based metrology instrument, feline musculoskeletal pain index (FMPI) for the evaluation of degenerative joint disease-associated pain in cats. Vet J. 2013;196(3):368–73.
33. Stadig S, Lascelles BDX, Nyman G, Bergh A. Evaluation and comparison of pain questionnaires for clinical screening of osteoarthritis in cats. Vet Rec. 2019;185(24):757.
34. Taylor S, Gruen M, KuKanich K, X Lascelles BD, Monteiro BP, Sampietro LR, et al. 2024 ISFM and AAFP consensus guidelines on the long-term use of NSAIDs in cats. J Feline Med Surg. 2024;26(4):1098612X241241951.
35. Adrian D, King JN, Parrish RS, King SB, C Budsberg S, Gruen ME, et al. Robenacoxib shows efficacy for the treatment of chronic degenerative joint disease-associated pain in cats: a randomized and blinded pilot clinical trial. Sci Rep. 2021;11(1):7721.
36. Johnson KA, Lee AH, Swanson KS. Nutrition and nutraceuticals in the changing management of osteoarthritis for dogs and cats. J Am Vet Med Assoc. 2020;256(12):1335–41.
37. Törnük F, Dirican S, Çilek S. Fish, Omega-3 Fatty Acids and their Functional Properties. (Poster)2nd İnternational Congress on Food and Nutrition, Istanbul, Book of Abstract. 2007. p.199.